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Effect of Sowing Dates and Nitrogen Levels on Population of Okra Jassids (*Amrasca biguttula biguttula* Ishida)

Rajendra Regmi[1*], Sujata Poudel[2], Ram Chandra Regmi[1] and Jiban Shrestha[3]

[1]Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[2]Nepal Agricultural Research Council, Horticulture Research Division, Khumaltar, Lalitpur, Nepal
[3]Nepal Agricultural Research Council, Agriculture Botany Division, Khumaltar, Lalitpur, Nepal

Abstract. Okra (Abelmoschus esculentus L. (Moench) is one of the most important vegetable crops grown in Nepal. The crop is susceptible to various insect pests of which jassids (Amrasca biguttula biguttula Ishida.) is most predominant which reduces production and deteriorates seed quality of okra. A field study was conducted at Horticulture Farm, Agriculture and Forestry University, Rampur, Chitwan, Nepal to elucidate the effect of sowing date and nitrogen levels on the population and damage of jassids from April to September 2018. Three levels of nitrogen (100, 200 and 300 kg N ha^{-1}) and five sowing dates (8th April, 20th April, 2nd May, 14th May and 26th May, 2018) were evaluated in randomized complete block design with three replications. Results indicated that the highest damage score was recorded in okra which was sown on 8th April (2.39) followed by 20th April (2.31) and 2nd May (1.26). The highest damage score of jassids was obtained with the use of nitrogen at the rate of 200 kg ha^{-1} (1.94) followed by 300 kg/ha (1.72) and 100 kg ha^{-1} (1.54). Mean population of jassids was maximum with okra sown on 20th April (29.91) and minimum with okra sown on 26th May (6.95). This study showed that late planting i.e. 26th May and applying low level of nitrogen i.e. 100 kg N $ha^{-1}$is an effective approach for reducing the jassids population and its damage in okra.

Keywords: jassids, nitrogen, okra, sowing date

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1. Introduction

Okra (*Abelmoschus esculentus* L.) is the oldest cultivated crops and presently grown in many countries and is widely distributed from Africa to Asia, southern Europe and America [1]. Okra

productivity of 11 mt ha^{-1} in Nepal. It is cultivated in 350 ha area with an average productivity of 13mt ha^{-1} in Chitwan [2]. It is usually consumed for its green tender fruits as a vegetable in different ways [1]. Okra green fresh fruits are nutritionally very rich with 35 calorie value. It contains carbohydrates (6.4%), proteins (1.9%), fats (0.2%), minerals (0.7%) and moisture (89.6%) [3]. Okra is one of the most important vegetables due to its nutritional [3][4] industrial [5] and medicinal [6] value.

*Corresponding author at: Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal

E-mail address: rregmi@afu.edu.np

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It is cultivated as summer and rainy season vegetable crops in Terai, inner Terai and some warmer places of Nepal mainly for its immature fruits [7].

One of the major constraints for the low productivity of okra in Nepal is that the crop is more vulnerable to the attack of insect pest, mites, nematodes, bacteria and virus. Insect pest cause heavy qualitative and quantitative losses in okra yield [8][9]. 72 species of insect pest attack this crop and among all Jassids (*Amrasca biguttula biguttula)* which is considered most serious and devastating pest of okra [10], and the most predominant sucking pest of this crop [11][12] which caused 40 to 63.41% yield loss on okra [8]. A reduction of 49.8 and 45.1 percent in plant height and number of leaves respectively occurred due to its attack [13]. Jassids causes quantitative as well as qualitative loss such as poor germination of seed after harvest and yellow fresh fruit color due to yellow vein mosaic virus [14]. Poor seed quality and low germination of seed after harvest of seed crop of okra if crop were severely infested by jassids [15]. Its infestation commences at very initial stages of crop growth [16] and continues till harvest depending on agro-climatic conditions. Agrochemicals are considered as a magical bullet in developing countries to increase the productivity. However, studies revealed that the farmers had very limited knowledge on adverse effect of pesticide and safe handling. Besides targeted pest species, the applied pesticide potentially hampers the non-targeted endangered species also [17].

Fresh vegetables are an essential part of a healthy diet as it is an important source of vitamins and minerals. However, in the present context vegetables are the source of poisonous toxic substance due to pesticide use [18]. Extremely hazardous pesticides banned by Nepal Government are being used in vegetables in Dhading districts [19]. Farmers in many countries are using different type's insecticides for the management of okra pests [20]. Jassids infestation varied in different growth stages of Okra plants and hampered okra production severely [21]. Extensive use of insecticides leads to the problems of pest resistance, resurgence, pesticides residues, destruction of beneficial fauna and environmental pollution [22]. Okra Jassids population is positively correlated with maximum and minimum temperatures and become maximum at hot days [23]. Maximum use of nitrogenous fertilizer increase Jassids population on okra [23].

Studying the appropriate time of planting and appropriate dose of fertilizer is crucial to escape the highest Jassids population to reduce use of excessive pesticides for fresh vegetable and healthy seed production of Okra. There has always been a need to develop a comprehensive control programme to overcome insect pest population. The present study deals to compare the population level of Jassids of okra sown with different levels of nitrogen and sowing date.

2. Materials and Methods

2.1. Field Experiment

The field experiment was conducted from February to September 2018 in Horticulture Farm, Agriculture and Forestry University, Rampur, Chitwan which is situated at 27^0 37' N latitude and 84^0 25' E longitudes with an elevation of 256 masl which falls in Bagamati Province. The average monthly weather data was collected from National Maize Research Program, Rampur, Chitwan and presented in Table 1.

Table 1. Average Monthly Weather Data, Rampur, Chitwan, Nepal, 2018

Months	Relative Humidity (%)	Maximum Temperature (°C)	Minimum Temperature (°C)	Total Rainfall (mm)
April	68.07	34.49	22.27	35.10
May	75.62	34.32	24.99	137.70
June	82.85	35.16	26.55	212.20
July	93.11	33.80	26.85	199.80
Aug	95.31	33.26	26.26	354.60
Sep	95.36	33.37	26.00	226.80

Arka Anamika variety of okra procured from nearby Agro-vet was grown for the experiment which was laid out in two factorial randomized complete block design with three replications. The first factor of the experiment was three levels of nitrogen viz: 100, 200 and 300 kg/ha and second factor was five sowing dates viz: 8th April, 20th April, 2nd May, 14th May and 26th May, 2018.

Required dose of fertilizer application for okra given by Nepal Agriculture Research Council (NARC) i.e. 200:180:60 kg NPK ha^{-1} which accounts 90:81:27 g NPK/ 4.5 m^2. Full dose of phosphorous and potash and half dose of nitrogen was applied during last field preparation and remaining half dose of nitrogen was applied in two equal spilt dose further at 25 DAS and 50 DAS. Individual plot size was 2 x 3 (6 m^2) where okra was sown at spacing of 50 x 30 cm^2, each plot with 6 rows and each row consists of 10 plants. The space between two replications was 1.0 m and between two plots were 1.0 m.

Ten sample plants from each plot was randomly selected and tagged and 3 leaves from each sample plant (1 each in lower, middle and top) was observed and the numbers of okra jassids (both adults and nymphs) was counted 30 days after sowing onward and repeated every week. For assessing the extent of foliage damage by okra jassids, a scale of 0-5, as described in Table 2 as given by [24]. First scoring was done at 30 DAS and recorded on every 15 days interval. It was continued till the commencement of harvesting of the crop.

Table 2. Rating Scale for Estimation of Severity of Damage by Okra Jassids (Both Nymph and Adult)

Plant condition	Score
No yellowing of leaves	0
Very few lower leaves showing yellowing symptoms	1
Few lower leaves showing yellowing symptoms	2
Many lower and some upper leaves showing yellowing symptoms and upper leaves showing curling symptoms	3
All the lower, most of the middle and some upper leaves showing yellowing symptoms, middle and upper leaves showing dark brick red patches	4
All the lower, middle and upper leaves showing yellowing symptoms; all the middle and upper leaves showing curling symptoms and most or all of leaves having dark brick red patches (necrosis): several plants crumpled.	5

2.2. Statistical Analysis

The number of jassids plant-1 was tabulated using Excel 2010 analyzed by using R-studio of R-stat software. The number of jassids plant-1 was analyzed after converting them into square root transformation (x+0.5)1/2 as suggested by [25]. All the analyzed data was subjected to DMRT for mean comparison at 5% level of significance [25] [26].

3. Results and Discussion

Damage score due to sowing date was found to be significantly different. At 30 DAS, damage score was found the highest with okra sown at 14th May (1.64) which is at par with okra sown at 2nd May (1.58) followed by okra sown at 26th May (1.13). Okra sown on 8th April (0.33) had the lowest damage score followed by okra sown on 20th April (0.83). Mid-season planting had the highest population of jassids which increased damage score however late planting had the lowest jassids population so the lowest damage scores (Table 3).

At 45 DAS, damage score was the highest with okra sown at 20th April (2.33) followed by sown at 2nd May (1.81), 14th May (1.73), 8th April (1.70) and 26th May (1.42). Finally, at 60 DAS, damage score was the highest with okra sown at 8th April (2.39) which were at par with okra sown on 20th April (2.31). The damage score was statistically similar among okra sown on 2nd May (1.26), 14th May (1.28) and 26th May (1.43) (Table 3). Overall, damage score was the highest with early planting as compared late planting. Our results are also in accordance with the studies carried out by Chandio [27] who observed the highest infestation of jassids was observed in last week of May in their study.

Damage score due to different nitrogen dose was found to be significant at 30 DAS. At 30 DAS, damage score was the highest at 300 kg N ha^{-1} (1.23) which was similar with 200 kg N ha^{-1} (1.14) but least damage score was found with 100 kg N ha^{-1} (0.95). At 45 DAS, the damage score was found to be non-significant among different nitrogen dose. At 60 DAS, damage score was the

highest at 200 kg N ha^{-1} (1.94) which was statistically similar with 300 kg N ha^{-1} (1.72) but the least damage score was found with 100 kg N ha^{-1} (Table 3). Mandal [28] reported decrease level of nitrogen with increasing phosphorus result lower infestation of Jassids in okra so lesser damage was reported with lower use of nitrogen. Our results was similar to that of Rustamani [29] who reported the higher doses of nitrogen fertilizer favored the multiplication of jassids. Kumar [30] also observed that increased dose of nitrogen favored higher population of jassids.

The number of jassids per plant at different date of sowing was found to be significantly different. At 30 DAS, mid-season planting of okra (2nd May) showed the highest population of jassids (29.36) which is followed by okra sown at 20th April (16.81) and 14th May (18.68). Okra sown at 8th April (2.73) had the lowest jassids population followed by okra sown on 26th May (10.33). Similarly, at 37 DAS, jassids infestation was found higher on okra sown on 20th April (42.01) followed by okra sown on 2nd May (19.61) and 14th May (18.52) whereas okra sown on 8th April (6.94) and on 26th May (8.37) had the lowest number of jassids per plant. Likewise, at 45DAS, the number of jassids sown on 20th April had the highest number of jassids per plant (58.14) followed by okra sown on 8th April (36.72). The okra sown on 26th May (10.76) had the lowest number of jassids followed by okra sown on 2nd May (22.34) and 14th May (20.91) (Table 4).

Table 3. Effect of Sowing Dates and Nitrogen Levels on Damage Score of Okra in Rampur, Chitwan, Nepal, 2018

Sowing dates	Damage Score		
	30 DAS	**45 DAS**	**60 DAS**
8th April	0.33^{d}	1.70^{b}	2.39^{a}
20th April	0.83^{c}	2.33^{a}	2.31^{a}
2nd May	1.58^{a}	1.81^{b}	1.26^{b}
14th May	1.64^{a}	1.73^{b}	1.28^{b}
26th May	1.13^{b}	1.42^{b}	1.43^{b}
Mean	1.10	1.8	1.73
SEm±	0.03	0.05	0.04
F test	***	***	***
CV (%)	25.38	21.31	19.83
Nitrogen levels (kg/ha)	30 DAS	45 DAS	60 DAS
100	0.95^{b}	1.65	1.54^{b}
200	1.14^{ab}	1.77	1.94^{a}
300	1.23^{a}	1.98	1.72^{ab}
Mean	1.10	1.8	1.73
SEm±	0.02	-	0.03
F test	*	ns	*
CV (%)	25.38	-	19.83

* Significant difference at 0.05 level of significance, ns= Non-significant, CV: Coefficient of variation, SEm±: Standard error of mean, DAS: Days after sowing, Means followed by the same letter in each column are not significantly different at 0.05 level of probability

At 50 DAS, jassids population was the highest on okra sown at 8th April (49.49) followed by okra sown on 20th April (29.02). Late sown specially on 26th May had the lowest Jassids population (6.81) followed by okra sown on 2nd May (16.54) and 14th May (15.78). At 60 DAS, jassids population was the highest on okra sown at 20th April (33.63) which was at par with okra sown on 8th April (32.00) followed by okra sown on 2nd May (19.29). Okra sown on 26th May had the lowest Jassids population followed by okra sown on 14th May. At 67 DAS and 75 DAS Jassids number per plant was the highest at early planting 8th April (28.00) followed by okra sown on 20th April (15.81, 13.98) and 2nd May (15.58, 11.94). Okra sown on 14th May and 26th May had the lowest Jassids population. Overall, the Jassids population was maximum in okra sown at 20th April whereas; its population was reduced at late sowing (Table 4). The number of Jassids per plant was statistically similar among different dose of nitrogen regarding all observation. However, the number of jassids was increased with increasing days after sowing but was maximum during 45DAS to 60 DAS (Table 5).

Table 4. Effect of Sowing Dates and Nitrogen Levels on Number of Jassids per Plant in Okra at Rampur, Chitwan, Nepal, 2018

Sowing dates	**30 DAS**	**37 DAS**	**45 DAS**	**50 DAS**	**60 DAS**	**67DAS**	**75DAS**	**Mean**
8th April	2.73d	6.94c	36.72b	49.49a	32.00a	28.00a	28.00a	26.27
	(1.63)	(2.61)	(5.96)	(6.94)	(5.48)	(5.14)	(5.14)	
20th	16.81b	42.01a	58.14a	29.02b	33.63a	15.81b	13.98b	29.91
April	(4.08)	(6.37)	(7.60)	(5.31)	(5.76)	(3.92)	(3.72)	
2nd May	29.36a	19.61b	22.34c	16.54c	19.29b	15.58b	11.94b	19.24
	(5.30)	(4.34)	(4.67)	(4.03)	(4.31)	(3.88)	(3.37)	
14th May	18.68b	18.52b	20.91c	15.78c	12.57c	4.12c	5.30c	13.70
	(4.28)	(4.27)	(4.55)	(3.95)	(3.52)	(2.02)	(2.19)	
26th May	10.33c	8.37c	10.76d	6.81d	5.19d	4.09c	3.11c	6.95
	(3.14)	(2.81)	(3.23)	(2.59)	(2.25)	(2.00)	(1.74)	
Mean	15.58	19.09	29.78	23.53	20.54	13.52	12.47	19.22
SEm±	15.19	26.88	25.96	23.98	19.81	11.53	10.43	-
	(0.17)	(0.21)	(0.18)	(0.18)	(0.22)	(0.15)	(0.17)	
F test	***	***	***	***	***	***	***	-
CV (%)	19.77	19.64	14.17	16.33	19.03	20.24	21.88	-
Nitrogen levels (kg/ha)	30 DAS	37 DAS	45 DAS	50 DAS	60DAS	67 DAS	75DAS	Mean
100	13.63	19.31	27.33	25.90	22.23	15.25	14.45	19.73
200	15.89	18.83	31.69	24.91	21.21	13.72	12.58	19.83
300	17.23	19.13	30.30	19.77	18.17	11.60	10.36	18.08
Mean	15.58	19.09	29.78	23.53	20.54	13.52	12.47	19.22
F test	ns	ns	ns	ns	ns	ns	ns	-

*** Significance at 0.001 level of significance, ns= Non-significant, CV: Coefficient of variation, SEm±: Standard error of mean, DAS: Days after sowing, Means followed by the same letter in each column are not significantly different at 0.05 level of probability. Numerical value within parenthesis in the column indicated square root transformed values.

The number of jassids per plant was minimum at 30 May (2.73) throughout research period which was increased gradually. About 36.72 jassids plant^{-1} was recorded during 15 June which fluctuated and was maximum during 6th July (38.5). Then after, its number decrease steadily which hit the lowest number during 14th September (3.11). Late planting can escape jassids population. The number of leaf hopper population in okra ascend from third week of June to second of July in Pakistan [31]. The jassids was recorded throughout the cropping period with the highest population during June but its population reduced at the last week of July in Bangladesh [32].

Table 5. Mean Number of Jassids per Plant at Different Sowing Dates in Okra at Rampur, Chitwan, Nepal, 2018

Sowing date	8th April	20th April	2nd May	14th May	26th May	Mean
30th May	2.73	-	-	-	-	2.73
7th June	6.94	-	-	-	-	6.94
15th June	36.72	-	-	-	-	36.72
22th June	49.49	16.81		-		33.15
29th June	32	42.01	-	-	-	37.05
6th July	28	58.14	29.36	-	-	38.5
13th July	28	29.02	19.61	-	-	25.54
20th July	-	33.63	22.34	18.68	-	24.83
27th July	-	15.81	16.54	18.52	-	16.95
3th August	-	13.98	19.29	20.91	10.33	16.12
10th August	-	-	15.58	15.78	8.37	13.24
17th August	-	-	11.94	12.57	10.76	11.75
24th August	-	-	-	4.12	6.81	5.47
31th August	-	-	-	5.3	5.19	5.24
7th September	-	-	-	-	4.09	4.09
14th September	-	-	-	-	3.11	3.11

4. Conclusion

It is concluded from the data that jassids population was significantly ($P<0.05$) affected by sowing dates. Maximum jassids population was recorded in okra sown on 20th April, whereas minimum jassids population was observed in okra sown on 26th May, 2018. Numerically minimum but statistically similar ($P>0.05$) jassids population was noted in okra planted with 100 kg N ha^{-1}. Therefore, late sowing (last week of May) and application of low level of nitrogen (100 kg N ha^{-1}) is recommended to reduce jassids population and its infestation.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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